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**EX PARTE**

May 8, 1998

Ms. Magalie Roman Salas
Secretary - Federal Communications Commission
1919 M Street, N.W. Room 222
Washington, D.C. 20554



RE: CC Docket Nos. 96-45 and 97-160

Dear Ms. Salas,

On May 7, 1998 Brian Staihr and Pete Sywenki of Sprint met with Chuck Keller, Richard Smith, Don Stockdale, Brad Wimmer, Brian Clopton, Bob Loube, Natalie Wales, Craig Brown, Mark Kennett, and Bill Sharkey of the FCC with regard to the above referenced dockets. The purpose of the meeting was to discuss the cost proxy models currently under consideration for Universal Service. Specifically, we 1) addressed the HAI Model Sponsors (HMS) May 5, 1998 ex parte submission, 2) provided additional data and information (attached to this letter) regarding the understatement of required distribution facilities in the HAI model, 3) discussed the need for access to the clustering data and methodology underlying the current version of the HAI model as well as access to any ongoing model revisions, 4) discussed alternative model approaches to building distribution plant to geocoded customer locations and alternatives for surrogate locations where geocoding is not avalilable, and 5) discussed the need for the Commission to assume control over any further model developments that it decides are necessary.

With respect to the HMS May 5, 1998 ex parte, despite the HMS continued efforts to downplay the significance of the flaw in their clustering algorithms and distribution module, the data and facts continue to reveal otherwise. The attached information illustrates that the problem is neither isolated nor small, but is pervasive and significant. Also, a review of the data on the diskette provided with the HMS ex parte further reveals the magnitude of the flaw. The data shows that for 424 out of 496 or 85% of the clusters for which data was provided, the HAI model builds less distribution plant than would be necessary just to simply connect the customer location points in the cluster. The total distribution route shortfall for these 424 clusters is over 7 million feet. For the lowest density clusters (those with 5 or fewer lines per square mile), the HAI model underbuilds in 115 out of 122 or 94% of the clusters. In these clusters, the total shortfall is over 3.7 million feet with an average shortage of more than 32,000 feet per cluster.

There can be no doubt that this causes a sizeable understatement of costs, particularly in sparsely populated rural areas.

With respect to HMS proposed revisions to "improve" upon the current clustering algorithms, while it may provide a minimal amount of incremental "improvement" over the current version, it would not actually fix the problem. The proposal would still result in a significant shortfall in required distribution. As long as customer dispersion is condensed in any way, such as converting polygons to rectangles or building cable only to the inside boundaries of perimeter lots as is done in the HAI model, underestimation of required cable will occur (see Sprint's April 29, 1998 ex parte submission). Therefore, contrary to the HMS assertions that it has a "simple" solution, the problem remains.

The original and three copies of this notice are being submitted to the Secretary of the FCC in accordance with Section 1.1206(b)(1) of the Commission's rules. If there are any questions, please call.

Sincerely,

Pete Sywenki

Attachment

cc: Craig Brown, Mark Kennett, Richard Smith, Brad Wimmer, Brian Clopton, Bob Loube, Don Stockdale, Chuck Keller, Bill Sharkey, Natalie Wales

# The Hatfield (HAI) Model 5.0a and the Underbuilding of Distribution Plant

Sprint has previously filed documents with this Commission in which we provided evidence demonstrating how customer locations are distorted in the Hatfield Model and how the resulting distribution plant built by the Model falls far short of that which would be required to construct a functioning telephone network.

That information was created after an initial (and incomplete) examination of a portion of the HAI's underlying data, which is the property of PNR & Associates.

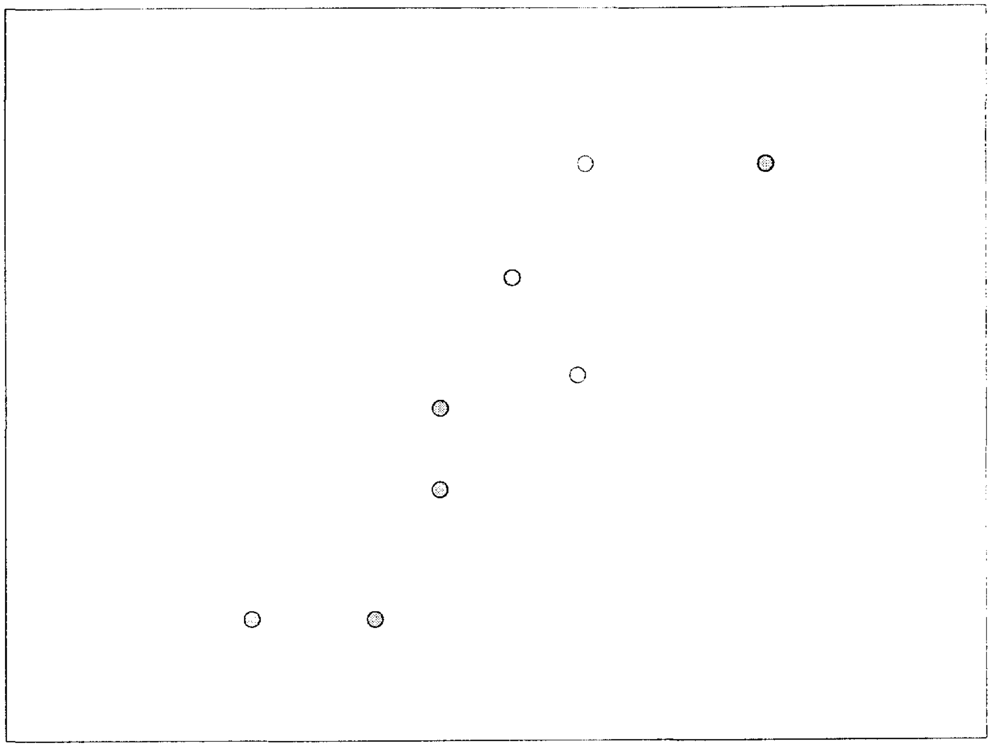
To date, Sprint has been denied further access to that data by the HAI Sponsors. As a result, we have not been able to provide a more extensive set of evidence revealing the magnitude of this flaw.

Now, however, Sprint has conducted an analysis using only data taken directly from the HAI Model itself. This analysis provides a sense of the magnitude and frequency with which HAI under-builds the local telephone network, particularly with regard to rural areas (which are of highest concern for universal service issues).

On the following pages, we list several facts and diagrams regarding the HAI's Preprocessing, Clustering and Loop Construction. Following this, we provide sample tables showing such results as…

| For a cluster in… | The <u>required</u> distribution cable (in feet) is… | And the Hatfield Model builds a total of… |
|---|---|---|
| Nevada Bell region | More than 15,323 | Less than 1,000 |
| GTE/Contel region | More than 15,402 | Less than 2,100 |
| Citizens Tel. region | More than 30,863 | Less than 1,700 |
| Sprint region | More than 27,534 | Less than 10,100 |

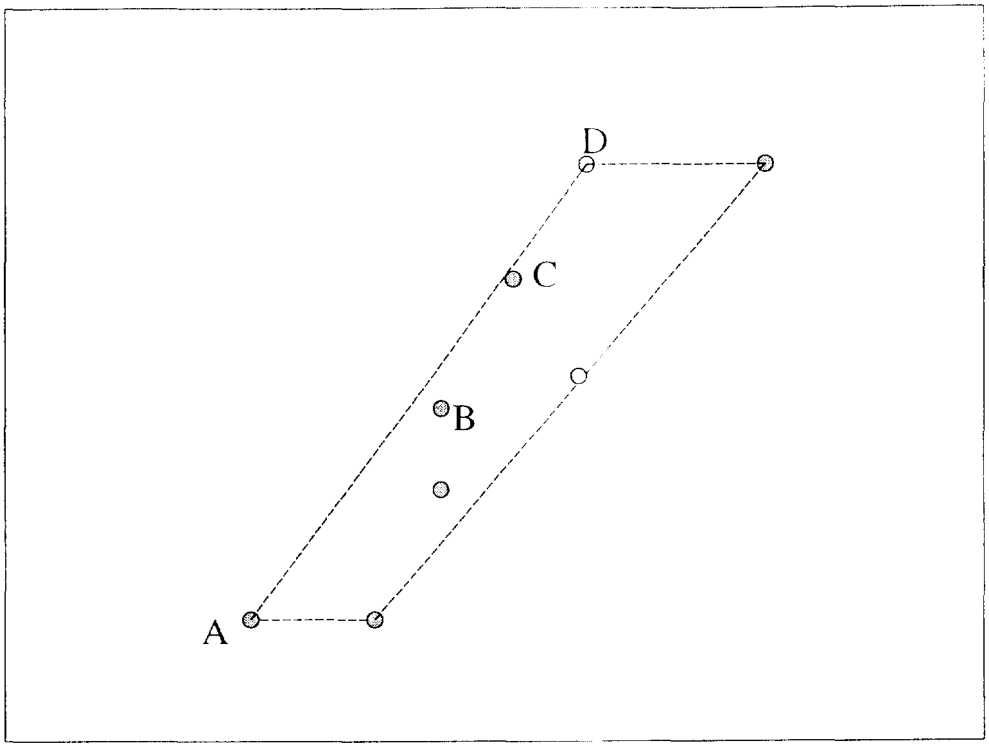
As the following pages show, this flaw permeates the HAI Model results for customers in rural locations, and seriously impacts the cost estimates produced by the model.



Facts Regarding the Hatfield Model's Preprocessing, Clustering and Loop Construction.

#1. Sets of customer locations are grouped together to form clusters. The points above represent such a set. These locations may be all actual locations (obtained from geocoding), or all surrogate locations (placed on a CB perimeter), or some combination of both.

These points are grouped together according to the criteria listed in the HAI Model Methodology.

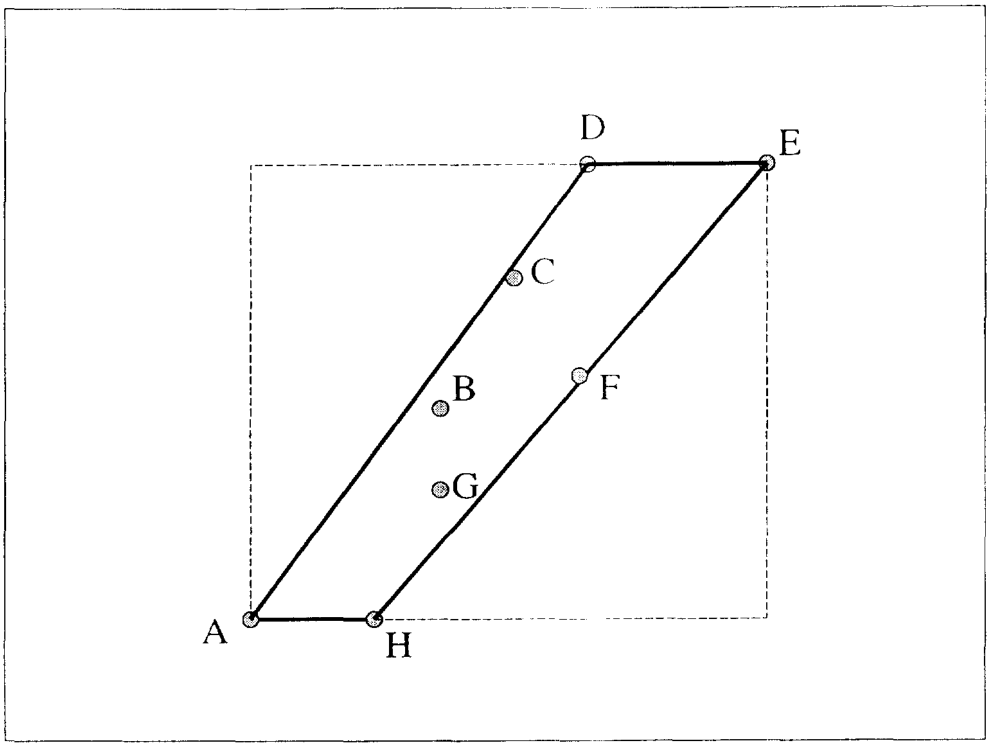



Facts Regarding the Hatfield Model's Preprocessing, Clustering and Loop Construction.

#2. The original points in cluster are surrounded by what is called the cluster's "convex hull". It is the dotted line above.

[All interior angles in a convex hull must be less than 180°, which is why the dotted line from A to D doesn't "angle in" to pick up point B. Doing so would result in an interior angle greater than 180°.]

The area within this convex hull is measured, and retained. In this example, the area of the convex hull is 1.9 square miles. (setting 1 inch = 1 mile.)

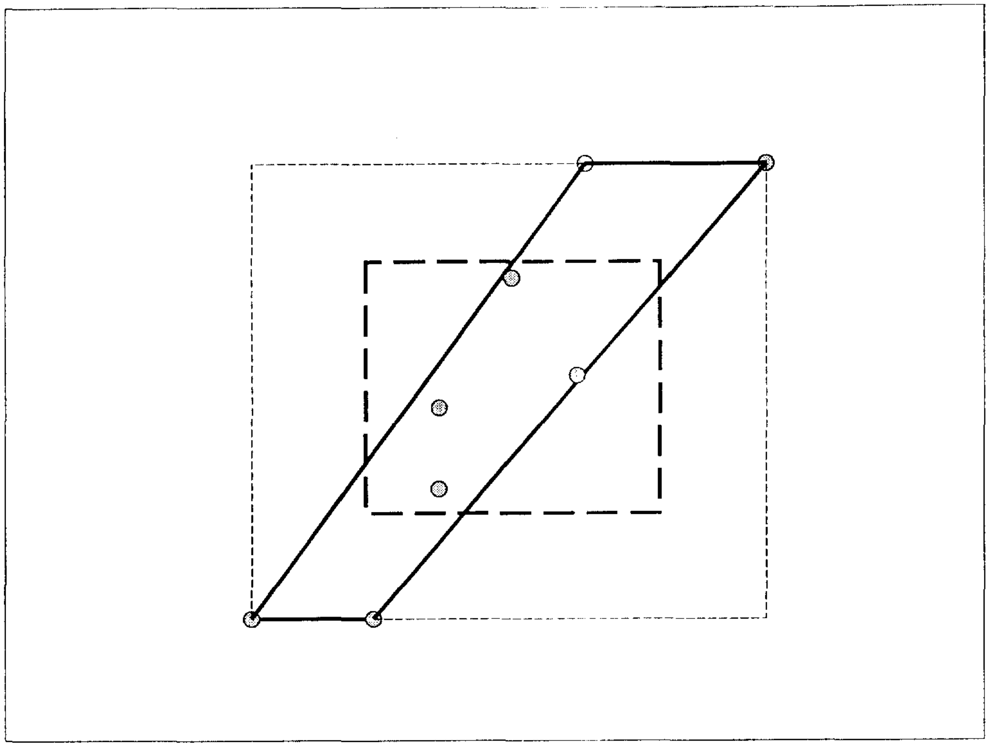



Facts Regarding the Hatfield Model's Preprocessing, Clustering and Loop Construction.

#3. The HAI Model next takes what is called the **minimum bounding rectangle** of the polygon. That is the rectangle (or square) which contains the furthest points N,S,E, and W. In this example, points D & E are northernmost, points A & H are southernmost, point A is farthest west and point E is farthest east.

The height of this rectangle over the width is the **aspect ratio**. In this example, the aspect ratio is approx. 0.9.

The HAI clustering uses this aspect ratio to convert the original polygon to a rectangle. This new rectangle will maintain the **area** of the original polygon (1.9 square miles) but will have the **shape** of the minimum bounding rectangle.

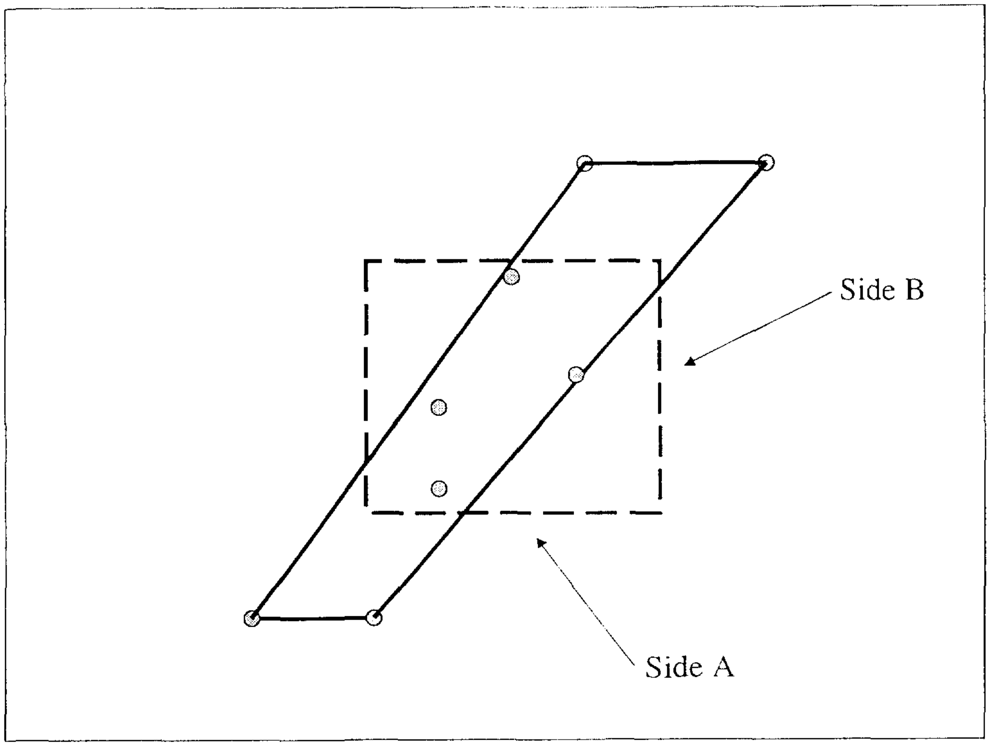


Facts Regarding the Hatfield Model's Preprocessing, Clustering and Loop Construction.

#4. The picture above displays the original polygon converted to a rectangle (the smaller rectangle with the dashed line.) This has the area of the original polygon, and the aspect ratio of the minimum bounding rectangle.

It is this smaller rectangle that actually enters the HAI Model, and will be discussed below. (For ease of exposition, the following pictures omit the larger, minimum bounding rectangle.)

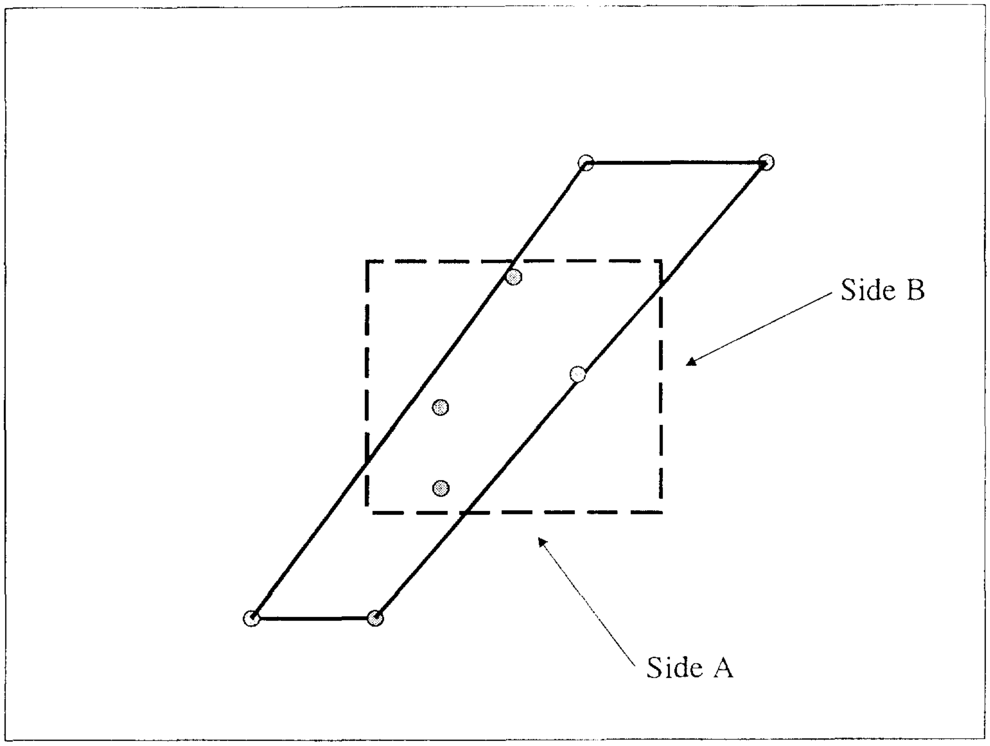
We will refer to the smaller rectangle as the "reduced rectangle".




Facts Regarding the Hatfield Model's Preprocessing, Clustering and Loop Construction.

#5. The HAI Model provides a user with the area of this reduced rectangle, as well as the aspect ratio. From these two pieces of information, it is straightforward to calculate the length of the rectangle's sides (shown above as Side A and Side B).

For the remainder of this discussion, the distance of Side A added to the distance of Side B will be referred to as the **height-plus-width,** measured in feet. This height-plus-width measure can be thought of as one half the perimeter of the reduced rectangle. It is this measure that is used in the following analysis.



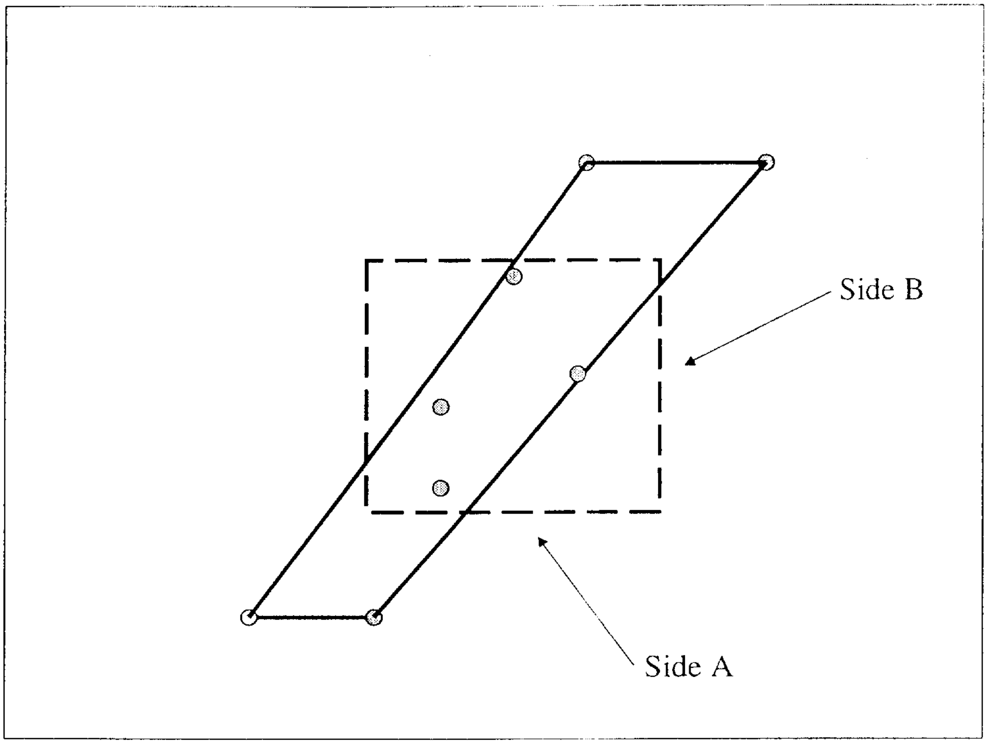

Facts Regarding the Hatfield Model (cont.)

#6. The HAI Model claims to build distribution cable to all locations in a cluster. However, initial analysis of the actual locations used in Nevada indicates that the HAI Model falls far short of building enough cable to connect all locations.

To measure the exact extent of this **underbuilding**, it is necessary to know actual point locations, in order to calculate the amount of required distribution cable (which is simply the shortest distance between all points).

To date, AT&T has not allowed these calculations to take place. In lieu of this analysis, it is still possible to obtain an imperfect measure (a grossly understated measure) of the degree to which the HAI Model underbuilds distribution plant.

This measure will use the **height-plus-width**, described earlier.



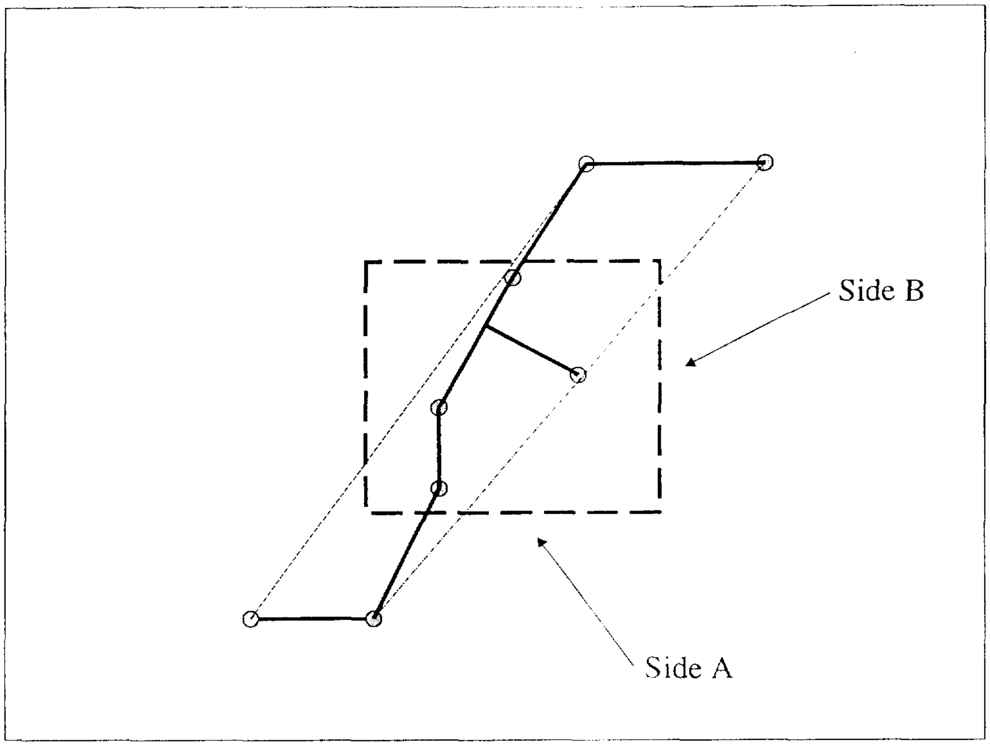

Facts Regarding the Hatfield Model (cont.)

#7. Simply stated, it is **mathematically impossible** for the distance connecting all points in a cluster to be less than the height-plus-width. (A detailed explanation of this fact follows in an Appendix.)

Therefore, it is also impossible for the actual required distribution cable in any cluster to be less than the height-plus-width.

Any cluster for which the HAI Model produces an amount of distribution cable that is less than the height-plus-width is a cluster that the HAI Model underbuilds.

IMPORTANT: **Height-plus-width does NOT represent the required amount of cable.** It represents a distance that is *less than* the required amount of cable. Therefore, a cluster with a distribution length greater than the height-plus-width distance is not necessarily a cluster with sufficient distribution cable.

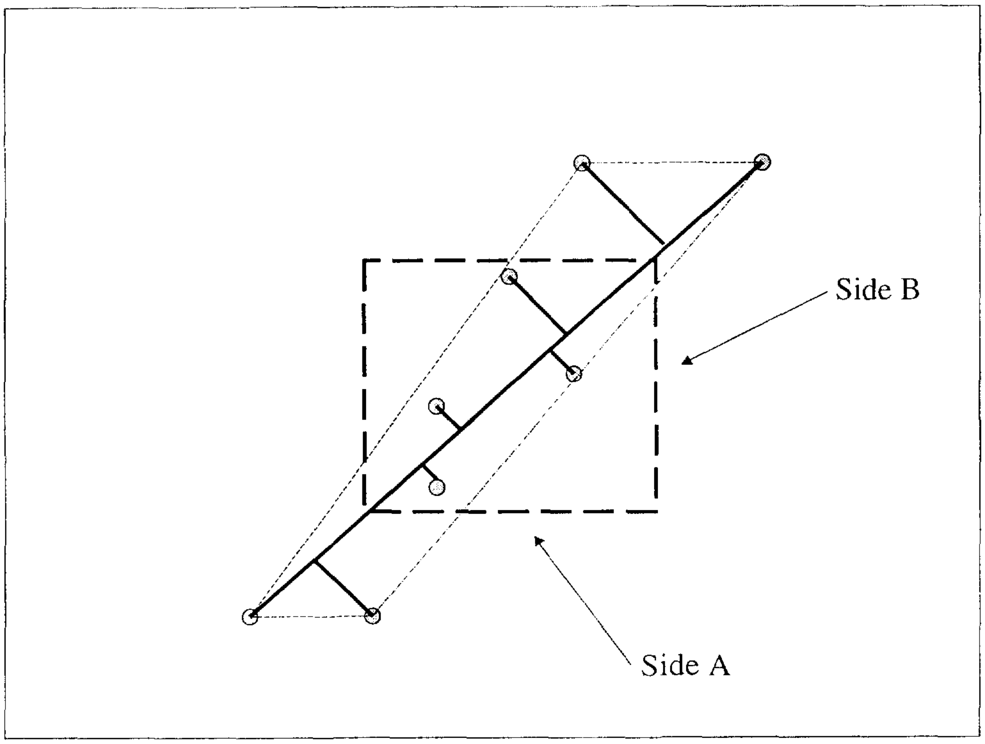



Facts Regarding the Hatfield Model (cont.)

Above, and on the following pages, for illustrative purposes only, are examples of potential distribution layouts. In every case, the amount of cable required to connect all customers dramatically exceeds the height-plus-width distance.

For example, in the picture above the total **height-plus-width** distance is less than 2.87 miles.

The distance connecting the points shown above (the solid lines) is over 4.25 miles.

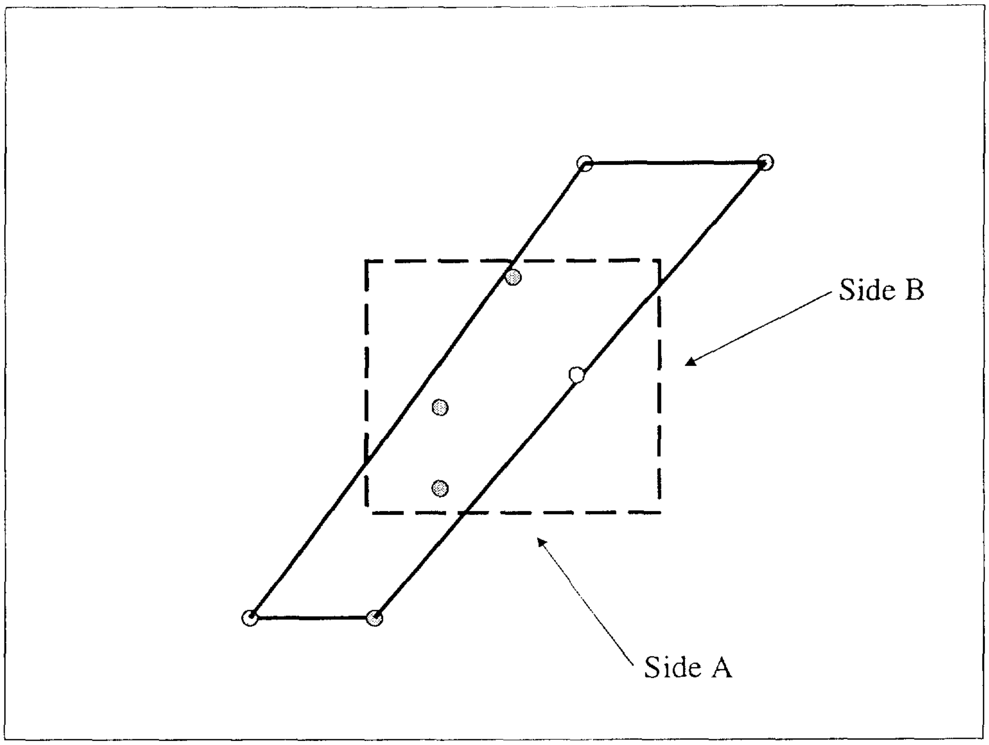



Facts Regarding the Hatfield Model (cont.)

example, for illustrative purposes only

In the picture above the total **height-plus-width** distance is less than 2.87 miles.

The distance connecting the points shown above (the solid lines) is over 5 miles.




In the tables that appear on the following pages, we list (by company) a sample of some of the clusters for which the HAI Model underbuilds distribution cable.

**The tables are only samples, not a complete listing.** For example, the Nevada Bell table lists only 25 clusters, but our analysis discovered over 200 clusters in Nevada Bell region that fell short.

Only main clusters are listed, to avoid any potential confusion caused by the treatment of outliers.

The tables list the total distribution the model builds as well as the height-plus-width distance.

Keep in mind that the height-plus-width distance measure is itself insufficient to connect all customers. So the cable shortages that appear on the following tables actually understate the amount by which HAI underbuilds.

SAMPLE OF NEVADA BELL MAIN CLUSTERS WITH DISTRIBUTION UNDER BUILT BY HAI 5.0

Note: Sum of height and width is less than the actual minimum amount of cable needed to connect points within the cluster.

| WIRE CENTER | CLUSTER | TOTAL LINES | SUM HEIGHT AND WIDTH | ACTUAL MAIN CLUSTER DISTRIBUTION BUILT BY HAI |
|---|---|---|---|---|
| BTMTNV11 | C019. | 8 | 27,059 | 9,182 |
| BTMTNV11 | C018. | 6 | 25,441 | 620 |
| BTMTNV12 | C001. | 16 | 1,367 | 530 |
| CSTVNV11 | C003. | 5 | 30,618 | 0 |
| DKWRNV11 | C001. | 10 | 2,343 | 850 |
| EMPRNV11 | C002. | 6 | 9,588 | 1,982 |
| EMPRNV11 | C016. | 5 | 12,981 | 5,317 |
| EMPRNV11 | C014. | 5 | 10,411 | 639 |
| EMPRNV11 | C015. | 6 | 12,803 | 1,236 |
| EMPRNV11 | C012. | 5 | 13,053 | 1,440 |
| EMPRNV11 | C008. | 6 | 16,141 | 4,251 |
| EMPRNV11 | C010. | 6 | 14,643 | 2,557 |
| EMPRNV11 | C004. | 6 | 18,941 | 5,290 |
| EMPRNV11 | C013. | 5 | 15,323 | 986 |
| EMPRNV11 | C001. | 8 | 22,181 | 2,259 |
| GABBNV11 | C005. | 8 | 17,712 | 6,009 |
| GABBNV11 | C002. | 11 | 27,399 | 13,316 |
| IMLYNV12 | C021. | 9 | 11,783 | 1,048 |
| IMLYNV12 | C030. | 11 | 19,734 | 8,198 |
| IMLYNV12 | C023. | 12 | 17,182 | 5,174 |
| IMLYNV12 | C022. | 5 | 20,768 | 6,006 |
| IMLYNV12 | C018. | 16 | 32,952 | 17,161 |
| IMLYNV12 | C029. | 5 | 20,899 | 3,105 |
| LVLCNV11 | C008. | 24 | 27,885 | 16,117 |
| MCGLNV11 | C003. | 8 | 18,075 | 4,828 |

In total for Nevada Bell the HAI 5.0 model under builds distribution in 83% of the main clusters in the 0 – 5 density range, and 35% of the main clusters in the 6 – 100 density range. These two density zones represent the vast majority of clusters for which universal service funding is needed.

SAMPLE OF CITIZENS MAIN CLUSTERS WITH DISTRIBUTION UNDER BUILT BY HAI 5.0

Note: Sum of height and width is less than the actual minimum amount of cable needed to connect points within the cluster.

| WIRE CENTER | CLUSTER | TOTAL LINES | SUM HEIGHT AND WIDTH | ACTUAL MAIN CLUSTER DISTRIBUTION BUILT BY HAI |
|---|---|---|---|---|
| ELKONVXF | C001. | 5 | 5,523 | 0 |
| GLFDNVXF | C001. | 11 | 33,576 | 9,305 |
| GLFDNVXF | C008. | 10 | 36,877 | 9,579 |
| JGGSNVXF | C001. | 5 | 16,258 | 659 |
| JGGSNVXF | C003. | 5 | 19,747 | 6,062 |
| MTLLNVXF | C002. | 5 | 35,490 | 5,035 |
| RBVYNVXG | C005. | 5 | 11,018 | 221 |
| RBVYNVXG | C006. | 7 | 27,970 | 4,054 |
| RBVYNVXG | C002. | 10 | 14,381 | 6,135 |
| RBVYNVXG | C001. | 6 | 33,397 | 7,032 |
| RBVYNVXG | C004. | 5 | 27,976 | 8,820 |
| RBVYNVXG | C003. | 7 | 33,442 | 10,669 |
| SLVPNVXF | C004. | 8 | 30,863 | 1,632 |
| SLVPNVXF | C003. | 6 | 26,779 | 6,519 |
| SLVPNVXF | C005. | 6 | 31,660 | 7,026 |
| SLVPNVXF | C001. | 5 | 28,496 | 13,728 |
| SLVPNVXF | C002. | 15 | 30,798 | 14,813 |
| TNPHNVXB | C004. | 14 | 21,497 | 8,191 |
| TNPHNVXB | C003. | 18 | 31,784 | 12,272 |
| WLLSNVXF | C005. | 6 | 8,803 | 1,020 |
| WLLSNVXF | C009. | 6 | 11,280 | 1,469 |
| WLLSNVXF | C008. | 8 | 16,085 | 4,371 |
| WLLSNVXF | C002. | 7 | 21,066 | 4,722 |
| WLLSNVXF | C012. | 5 | 17,446 | 5,467 |
| WLLSNVXF | C003. | 8 | 23,745 | 6,288 |
| WLLSNVXF | C010. | 8 | 25,634 | 6,737 |
| WLLSNVXF | C001. | 8 | 25,616 | 6,981 |
| WLLSNVXF | C004. | 9 | 24,697 | 7,979 |

In total for Citizens the HAI 5.0 model under builds distribution in 78% of the main clusters in the 0 – 5 density range, and 25% of the main clusters in the 6 – 100 density range. These two density zones represent the vast majority of clusters for which universal service funding is needed.

SAMPLE OF CONTEL MAIN CLUSTERS WITH DISTRIBUTION UNDER BUILT BY HAI 5.0

Note: Sum of height and width is less than the actual minimum amount of cable needed to connect points within the cluster.

| WIRE CENTER | CLUSTER | TOTAL LINES | SUM HEIGHT AND WIDTH | ACTUAL MAIN CLUSTER DISTRIBUTION BUILT BY HAI |
|---|---|---|---|---|
| GVRSNVXF | C001. | 25 | 30,872 | 25,385 |
| GVRSNVXF | C006. | 38 | 20,123 | 13,681 |
| GVRSNVXF | C002. | 6 | 15,953 | 3,502 |
| JKVYNVXF | C003. | 6 | 600 | 0 |
| JKVYNVXF | C004. | 22 | 22,777 | 12,399 |
| SMTHNVXF | C004. | 9 | 17,151 | 4,992 |
| SMTHNVXF | C001. | 24 | 31,387 | 24,897 |
| SMTHNVXF | C002. | 21 | 34,399 | 27,494 |
| SMTHNVXF | C009. | 5 | 15,402 | 2,077 |
| SMTHNVXF | C005. | 23 | 33,701 | 26,637 |
| SMTHNVXF | C010. | 30 | 36,630 | 30,824 |
| STLNNVXF | C002. | 5 | 1,825 | 340 |
| TPLKNVXA | C005. | 6 | 16,421 | 2,611 |
| TPLKNVXA | C001. | 11 | 17,934 | 9,144 |
| TPLKNVXA | C004. | 14 | 23,843 | 8,404 |
| TPLKNVXA | C007. | 36 | 29,123 | 25,066 |
| YRTNNVXA | C002. | 12 | 10,374 | 1,278 |
| YRTNNVXA | C001. | 7 | 24,736 | 5,534 |
| YRTNNVXA | C004. | 11 | 13,555 | 6,252 |
| YRTNNVXA | C007. | 24 | 16,328 | 12,728 |
| YRTNNVXA | C003. | 25 | 33,717 | 31,535 |
| YRTNNVXA | C015. | 15 | 13,756 | 4,873 |
| YRTNNVXA | C014. | 21 | 31,737 | 18,940 |

In total for Contel the HAI 5.0 model under builds distribution in 59% of the main clusters in the 0 – 5 density range, and 28% of the main clusters in the 6 – 100 density range. These two density zones represent the vast majority of clusters for which universal service funding is needed.

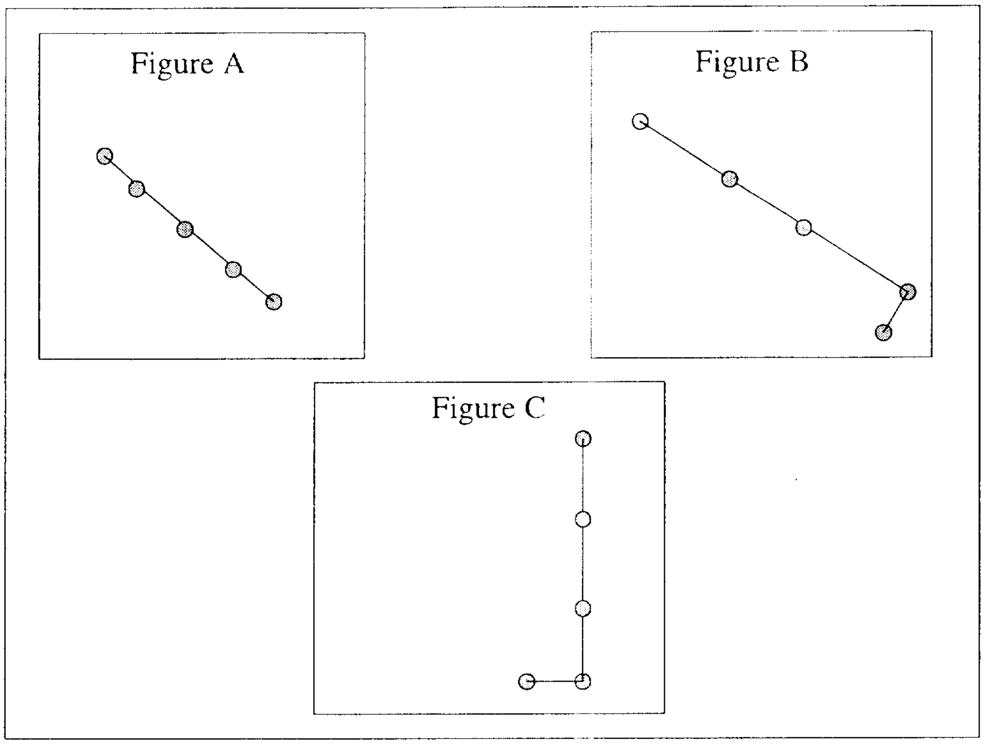
SAMPLE OF CENTEL MAIN CLUSTERS WITH DISTRIBUTION UNDER BUILT BY HAI 5.0

Note: Sum of height and width is less than the actual minimum amount of cable needed to connect points within the cluster.

| WIRE CENTER | CLUSTER | TOT LINES | SUM HEIGHT AND WIDTH | ACTUAL MAIN CLUSTER DISTRIBUTION BUILT BY HAI |
|---|---|---|---|---|
| JEANNVXF | C005. | 7 | 7,304 | 156 |
| JEANNVXF | C007. | 7 | 5,161 | 415 |
| JEANNVXF | C003. | 12 | 19,474 | 5,045 |
| JEANNVXF | C004. | 9 | 21,503 | 6,871 |
| JEANNVXF | C012. | 8 | 20,443 | 8,105 |
| JEANNVXF | C008. | 25 | 28,052 | 9,196 |
| JEANNVXF | C006. | 9 | 27,534 | 10,076 |
| JEANNVXF | C001. | 14 | 28,806 | 10,456 |
| JEANNVXF | C013. | 9 | 27,206 | 16,637 |
| MTCHNVXF | C015. | 5 | 2,407 | 605 |
| MTCHNVXF | C001. | 9 | 17,683 | 5,234 |
| MTCHNVXF | C005. | 9 | 14,125 | 6,001 |
| MTCHNVXF | C009. | 9 | 13,076 | 6,140 |
| MTCHNVXF | C002. | 8 | 12,828 | 6,407 |
| MTCHNVXF | C010. | 10 | 15,741 | 7,901 |
| MTCHNVXF | C016. | 9 | 17,126 | 8,918 |
| MTCHNVXF | C008. | 11 | 23,719 | 13,094 |
| MTCHNVXF | C013. | 12 | 27,597 | 14,784 |
| NLSNNVXB | C002. | 7 | 23,230 | 8,741 |
| SRCHNVXF | C003. | 7 | 10,607 | 2,338 |
| SRCHNVXF | C002. | 7 | 10,567 | 3,491 |
| SRCHNVXF | C006. | 14 | 29,717 | 9,897 |
| SRCHNVXF | C011. | 13 | 35,069 | 12,499 |
| SRCHNVXF | C010. | 11 | 30,164 | 15,558 |
| SRCHNVXF | C009. | 22 | 30,094 | 16,373 |

In total for Centel the HAI 5.0 model under builds distribution in 78% of the main clusters in the 0 – 5 density range, and 28% of the main clusters in the 6 – 100 density range. These two density zones represent the vast majority of clusters for which universal service funding is needed.

Appendix: Why it is Mathematically Impossible for the Distance Connecting All Points in a Cluster to be Less than the Height-Plus-Width of the Reduced Rectangle.




Facts Regarding the Hatfield Model (cont.)

All main clusters must have 5 points (see HAI Documentation).

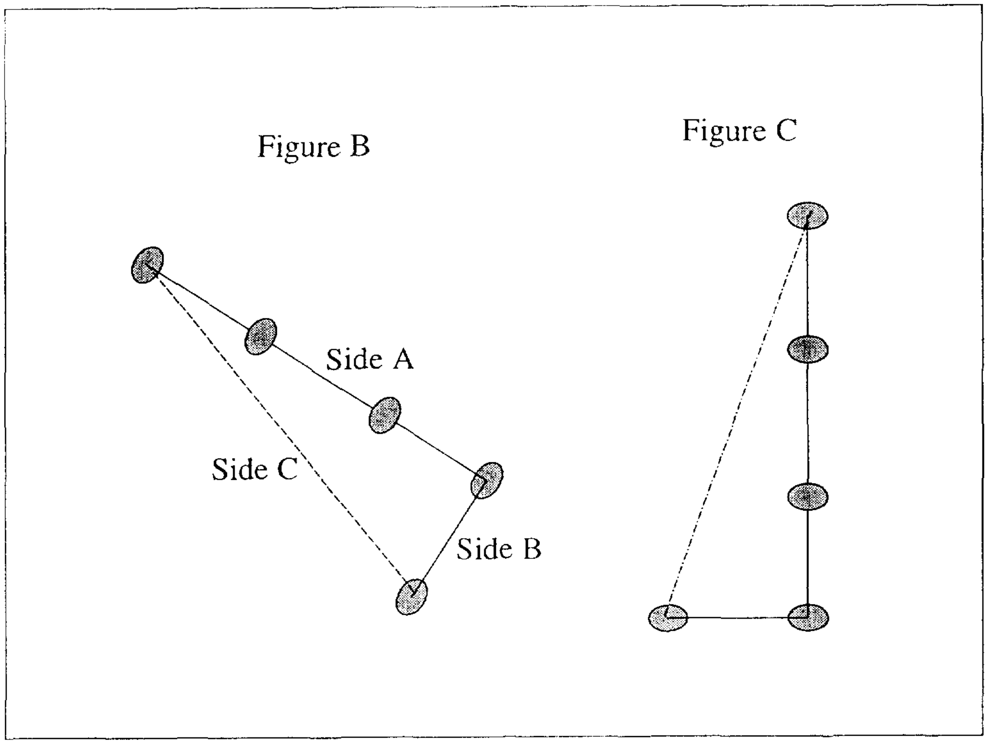
In Figure A, all points fall into direct line. By definition this cluster has no area. Impossible to create convex hull.

In Figures B and C, it is possible to create polygons having convex hull and area.

Although original polygons in Figures B and C will be identical, minimum bounding rectangles will be dramatically different (see following pages).

These two figures (B&C) will be used to illustrate fact that height-plus-width of reduced rectangle can only be less than minimum distance required to connect all points.

All other polygons can be viewed as variations of Figures B and C.




Facts Regarding the Hatfield Model (cont.)

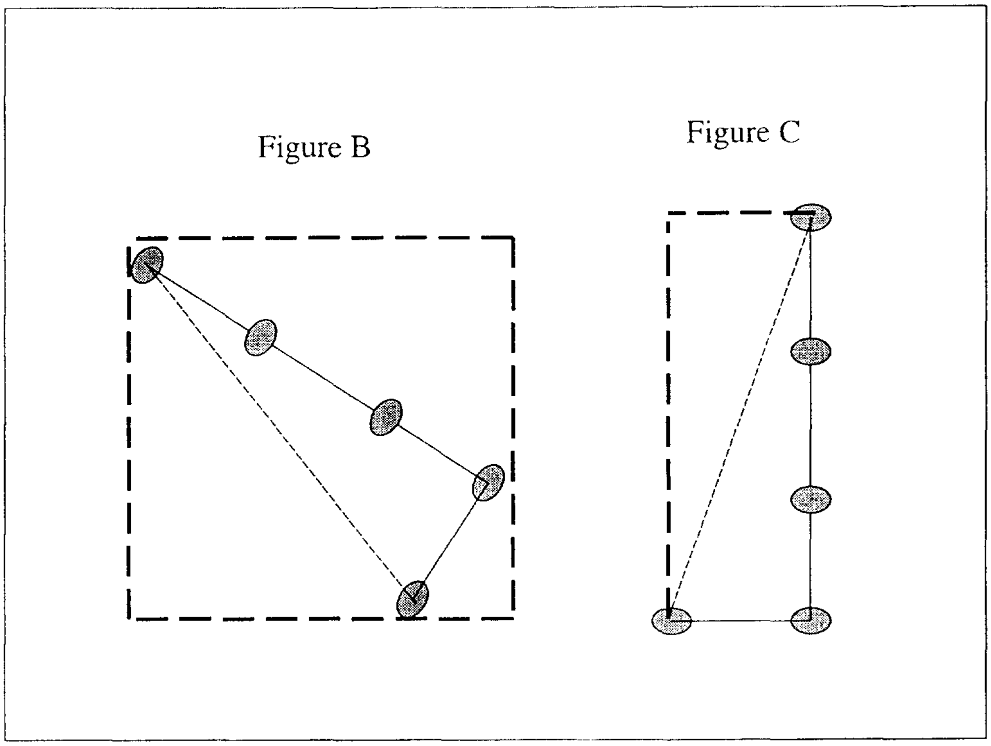
Area of both polygons is identical, approximately 0.71 square miles (where 1 inch = 1 mile).

Approximate Lengths of Sides (for future reference)-

Side A: 2.06 miles (10,900 feet)

Side B: 0.69 miles (3,630 feet)

Side C: 2.19 miles (11,550 feet)



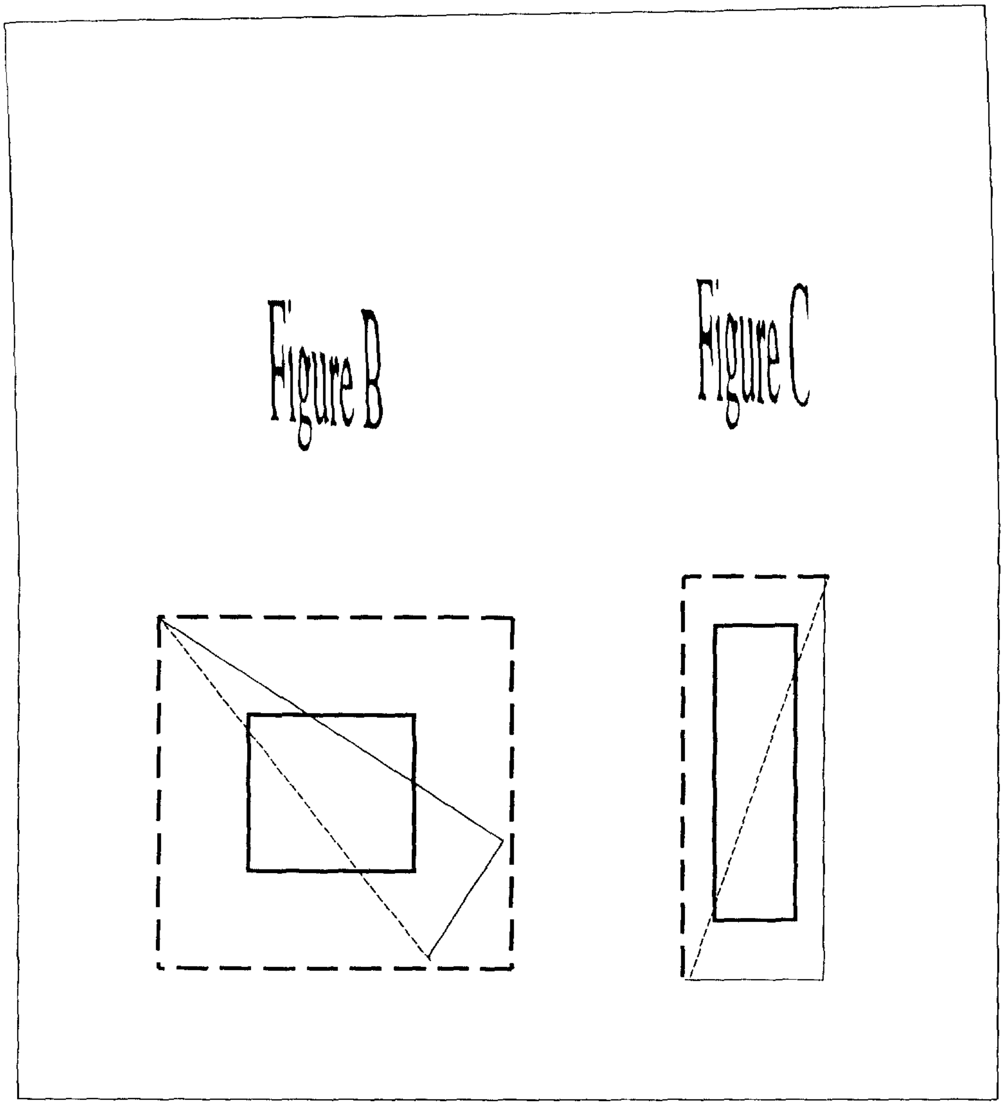

Facts Regarding the Hatfield Model (cont.)

Minimum bounding rectangles for each polygon are dramatically different. Each will produce a different aspect ratio, and a differently shaped reduced rectangle.

Recall, aspect ratio is height over width.

Aspect Ratio of Figure B is approximately 1.

Aspect Ratio of Figure C is approximately 3.




Facts Regarding the Hatfield Model (cont.)

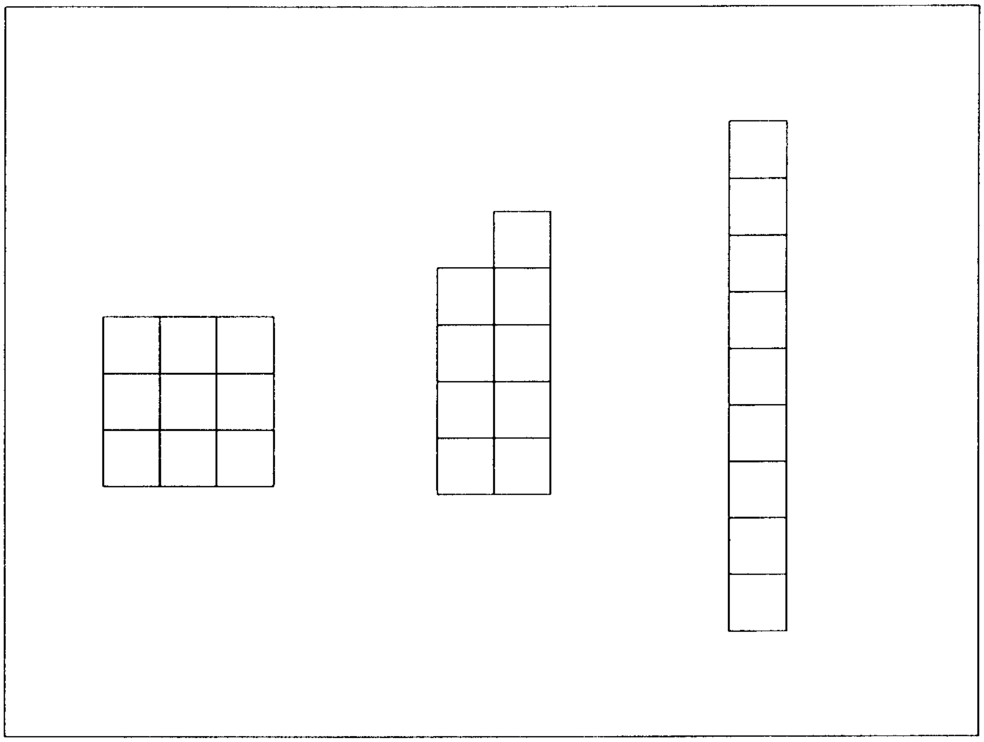
(points removed for ease of exposition)

Picture above shows the corresponding reduced rectangle (heavier lines) for each of the original polygons.

Each reduced rectangle has the same exact area, which is exactly equal to the area of the original polygon, 0.71 square miles.

However the distance figures "height-plus-width" can differ significantly.

Figure B, the reduced rectangle that appears more square-like, has height-plus-width distance of 1.68 miles.



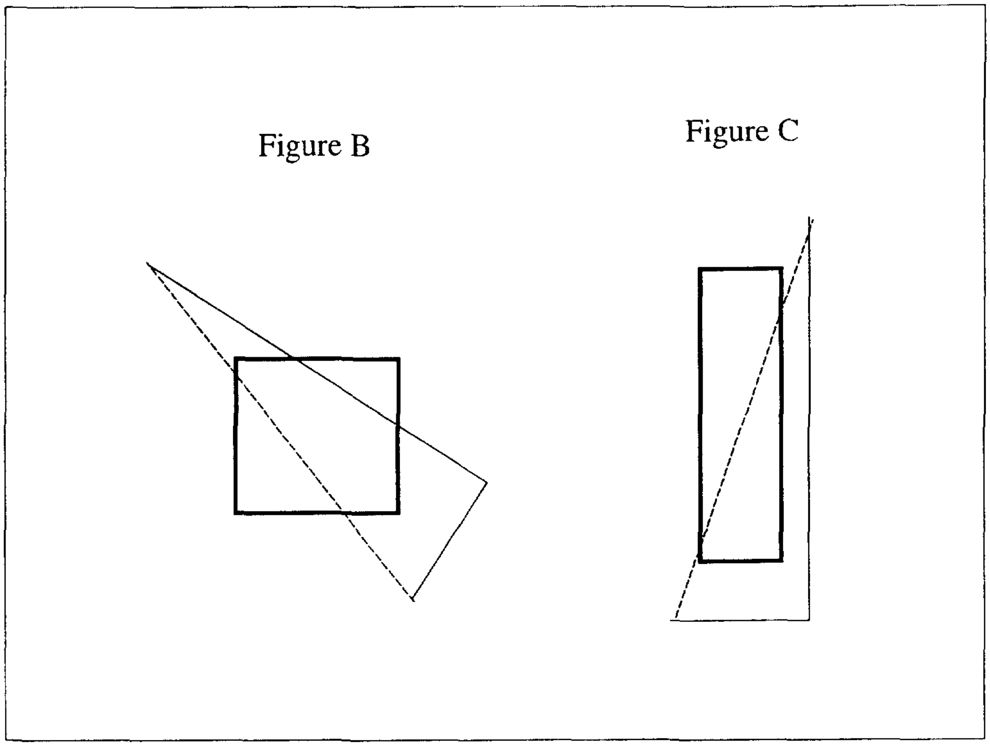
***If two polygons have the same area, the measure of the perimeter will be shortest for the polygon which most closely approaches the shape of a square.***

This is illustrated above using three polygons with identical area (9 square miles if 1 box = 1 square mile).

The figure on the far left has a perimeter distance of 12 miles.
The figure on the far right has a perimeter distance of 20 miles.
The figure in the center has a perimeter distance of 14 miles.

**Implications for the HAI Model:**

**Whenever the convex hull of an original cluster is converted to the reduced rectangle (with identical area), it becomes relatively more square-shaped. Consequently, the perimeter measure decreases in every case.**



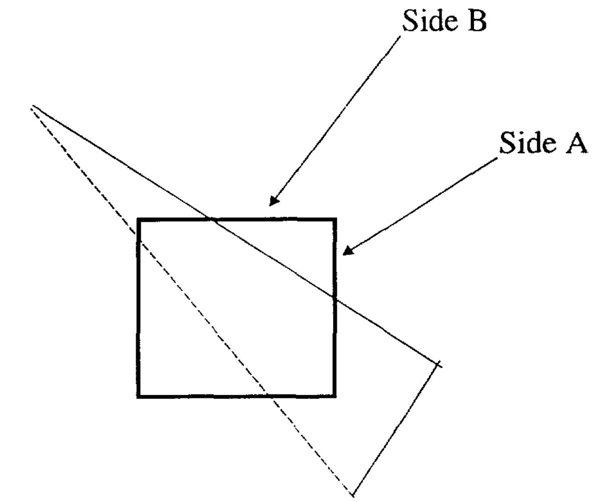

Facts Regarding the Hatfield Model (cont.)

In the figures above, the perimeter of reduced rectangle B is less than the perimeter of reduced rectangle C. But the perimeters of **both** reduced rectangles are less than the perimeters of the original polygons (which are identical).

The distance measure **height-plus-width** represents exactly one half the perimeter of (any) reduced rectangle. By definition and the result above, this is less than one half the perimeter of the original polygon.

<u>It is geometrically impossible to connect the bounding points of any polygon (not to mention any interior points) with only one half the distance of the perimeter. Consequently, it is also impossible to connect the same points with **less** than one half the perimeter distance.</u>

Figure B




Implication of Hatfield Model Results:

**Any main cluster in which the Total Distribution built falls short of the distance of side A plus side B is a cluster in which the model falls short of building a functioning, operable network.** Total Distribution is measured: [(Hatfield Distribution Module, Calculations Worksheet Cell BU minus Cell CQ (outlier road distance)]

There is no exception to the rule that it is geometrically impossible to connect the bounding points of any polygon with only one half the distance of the perimeter.

There is, however, one rare exception to the rule that the polygon perimeter is reduced when it is converted to the reduced rectangle. This occurs when the polygon is exactly the size and shape of the minimum bounding rectangle. This is discussed below...